

## Standard 6.2.4

<p><b>Strand 6.2:</b> <b>ENERGY AFFECTS MATTER</b></p>	<p>Matter and energy are fundamental components of the universe. Matter is anything that has mass and takes up space. Transfer of energy creates change in matter. Changes between general states of matter can occur through the transfer of energy. Density describes how closely matter is packed together. Substances with a higher density have more matter in a given space than substances with a lower density. Changes in heat energy can alter the density of a material. Insulators resist the transfer of heat energy, while conductors easily transfer heat energy. These differences in energy flow can be used to design products to meet the needs of society.</p>	
<p><b>Standard: 6.2.4</b> <b>MS-PS3-3</b></p>	<p><b>Design</b> an object, tool, or process that minimizes or maximizes heat energy transfer. Identify criteria and constraints, develop a prototype for iterative testing, analyze data from testing, and propose modifications for optimizing the <b>design solution</b>. Emphasize demonstrating how the <u>structure</u> of differing materials allows them to <u>function</u> as either conductors or insulators.</p>	
	<p><b>Constructing Explanations and Designing Solutions</b> Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific ideas, principles, and theories.</p> <ul style="list-style-type: none"> <li>Apply scientific ideas or principles to design, construct, and test a design of an object, tool, process or system.</li> </ul>	<p><b>Structure and Function</b> Structures can be designed to serve particular functions by taking into account properties of different materials, and how materials can be shaped and used.</p>
<p><b>DCI</b></p>	<p><b>PS3.A: Definitions of Energy</b></p> <ul style="list-style-type: none"> <li>Temperature is a measure of the average kinetic energy of particles of matter. The relationship between the temperature and the total energy of a system depends on the types, states, and amounts of matter present.</li> </ul> <p><b>PS3.B: Conservation of Energy and Energy Transfer</b></p> <ul style="list-style-type: none"> <li>Energy is spontaneously transferred out of hotter regions or objects and into colder ones.</li> </ul> <p><b>ETS1.A: Defining and Delimiting an Engineering Problem</b></p> <ul style="list-style-type: none"> <li>The more precisely a design task's criteria and constraints can be defined, the more likely it is that the designed solution will be successful. Specification of constraints includes consideration of scientific principles and other relevant knowledge that is likely to limit possible solutions.(secondary)</li> </ul> <p><b>ETS1.B: Developing Possible Solutions</b></p> <ul style="list-style-type: none"> <li>A solution needs to be tested, and then modified on the basis of the test results in order to improve it. There are systematic processes for evaluating solutions with respect to how well they meet criteria and constraints of a problem. (secondary)</li> </ul>	
<p><b>Student Friendly Objectives</b></p>	<p><b>I can recognize that differing materials allow them to function as either conductors or insulators and can design an object that minimizes or maximizes heat energy transfer.</b></p> <p><b>I can test my design, analyze data from testing, and propose modifications for improvement.</b></p>	
<p><b>Anchor</b></p>	<p>Heat transfer can be maximized or minimized by different types of materials.</p>	

<b>Phenomena</b>		
<b>Possible Scenarios</b>	thermos keeping liquid either hot or cold materials acting as conductors or insulators	
<b>Vertical Learning Progression Alignment</b>	<b>Previous Science Content (Discussed in K-5 Standards)</b>	<b>Future Science Content (Discussed in 9-12 Standards)</b>
	<ul style="list-style-type: none"> <li>● Moving objects contain energy. The faster the object moves, the more energy it has.</li> <li>● Energy can be moved from place to place by moving objects, or through sound, light, or electrical currents.</li> <li>● Energy can be converted from one form to another form.</li> </ul>	<ul style="list-style-type: none"> <li>● The total energy within a system is conserved.</li> <li>● Energy transfer within and between systems can be described and predicted in terms of energy associated with the motion or configuration of particles (objects).</li> <li>● Systems move toward stable states.</li> </ul>

**What students should be doing:**

1. Using scientific knowledge to generate design solutions
  - a. Given a problem to solve that requires either minimizing or maximizing thermal energy transfer, students design and build a solution to the problem. In the designs, students:
    - i. Identify that thermal energy is transferred from hotter objects to colder objects.
    - ii. Describe different types of materials used in the design solution and their properties (e.g., thickness, heat conductivity, reflectivity) and how these materials will be used to minimize or maximize thermal energy transfer.
    - iii. Specify how the device will solve the problem
  
2. Describing criteria and constraints, including quantification when appropriate
  - a. Students describe the given criteria and constraints that will be taken into account in the design solution:
    - i. Students describe criteria, including:
      1. The minimum or maximum temperature difference that the device is required to maintain.
      2. The amount of time that the device is required to maintain this difference.
      3. Whether the device is intended to maximize or minimize the transfer of thermal energy.
    - ii. Students describe constraints, which may include:
      1. Materials.
      2. Safety.
      3. Time.
      4. Cost.
  
3. Evaluating potential solutions
  - a. Students test the device to determine its ability to maximize or minimize the flow of thermal energy, using the rate of temperature change as a measure of success.
  - b. Students use their knowledge of thermal energy transfer and the results of the testing to evaluate the design systematically against the criteria and constraints.